



## A Cubic Foot Per Second

By Eric Muller

Most stream flows in the United States are measured in cubic feet per second or cfs. However, cubic feet per second are not familiar to most students. This activity is meant as a way to visualize a cubic foot per second.

### Materials:

- Empty plastic or cardboard ½ gallon milk containers (at least 2)
- Empty 1-gallon Plastic milk jug (at least 2)
- Empty 5-Gallon (water cooler) bottle (at least 1)
- Rulers / tape measures in inches
- Calculators
- Timer



### To do and notice:

#### A. What is a cubic foot?

1. Hold up a standard 1-foot ruler. Tell participants that a cubic foot is a box that would be one foot by one foot by one foot. Tell them that are going to compare their containers to a cubic foot.
2. Present the various empty containers/jugs to participants. Have them measure each dimension of their container in inches (pretend the containers are filled to standard fluid levels).
3. Calculate each container's volume in cubic inches.
4. A cubic foot is 12 x 12 x 12 inches or 1728 cubic inches.  
Calculate how many cubic feet each container contains (Hint: each container mentioned in the materials section above is only a fraction of a cubic foot).

Example of calculation:

$$\frac{\text{Size of your container in ft}^3}{\text{Volume of your container in in}^3} = \frac{1 \text{ ft}^3}{1728 \text{ in}^3}$$

#### What's going on?

Were you surprised by your results? Most people feel that a gallon is almost a cubic foot.... and a 5 gallon container must be larger than a cubic foot.... but it isn't. A cubic foot is about 7.5 gallons (US).

Here are the actual conversions:

- ½ gallon cardboard container is about .07 ft<sup>3</sup>
- 1-gallon plastic jug is about .13 ft<sup>3</sup>
- 5-gallon container is about 0.67 ft<sup>3</sup>

## B. What is a cubic foot per second?

1. Make an equivalent cubic foot volume with your containers.  
Here's an example:

One cubic foot = 7.48 U.S. gallons  
or about 7.5 gallons,

To represent this, you could use:

One 5-gallon bottle, two 1-gallon jugs and one  $\frac{1}{2}$  - gallon

See picture in upper corner of this document –  
That's me with a cubic foot worth of containers.



If possible, make and organize several cubic feet equivalents with your containers.

2. Have some one or multiple people hold their cubic feet equivalents.
3. Designate a location that every person carrying a cubic foot will pass.
4. Have each person carry their cubic foot past that location in one second (use a timer or just estimate).
5. Have several people carry their containers past the designated point in one second.



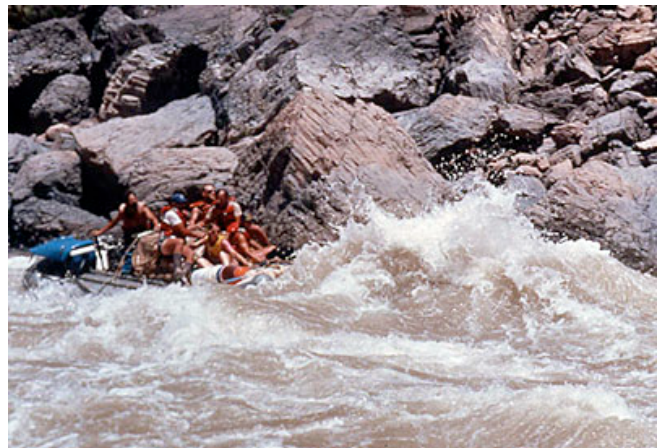
### What's going on?

One person carrying one cubic foot past a designated location in one second is a cubic foot per second or cfs, in this case for only one second. If for example, 10 people each carrying one cubic foot of containers, walks in a single file line past a given spot in 10 seconds, then this would still be one cfs, but for a duration of 10 seconds.

However, if the scenario changes so that all 10 people walk past the same spot in one second, then that's 10 cfs in one second (for a duration of one second).

### So What?

Some sources of water might only run temporally during the year (ephemeral). Some might run all year long, but in a slow trickle. However, many U.S. Rivers can carry hundreds to hundreds of thousands of cubic feet of water per second for dozens of years on end. The largest rivers in the U.S. like the Columbia River run at an average rate of about  $\frac{1}{4}$  million cfs and the Mississippi runs at an average of about  $\frac{1}{2}$  million cfs. However, the largest river in the world, the Amazon runs an average of 7.5 million cfs.



(Picture to right – the Colorado River averages between 10 to 20 thousand cfs).

Optional things to do:

A. Visual a cubic foot with other containers.

- i. Use other types of containers to show a cubic foot.
- ii. Convert to metric containers  
(1 cubic foot = 28.3 liter)

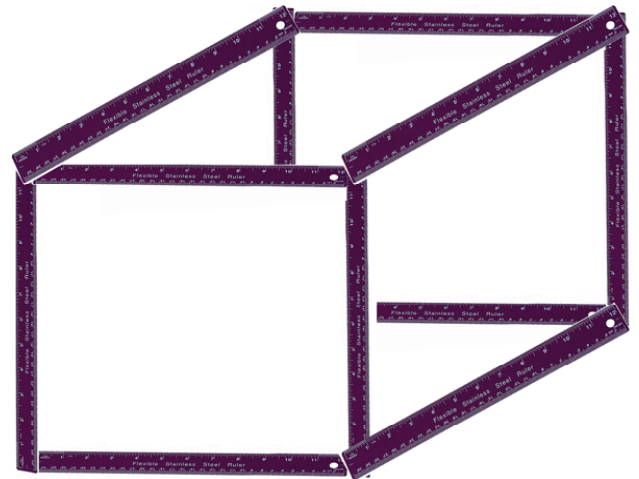
A cubic foot can be approximated with fourteen 2-liter bottles plus a ½ liter bottle (see image to right).



B. Make a cubic foot with rulers. Tape 12 one-footlong rulers together, like in the picture below.

C. How much does a cubic foot of water weight?

Note: All the cubic feet of containers in the above pictures were empty because a cubic foot of water weighs a lot.... 62.4 pounds or 28.3 kilograms....and that's tough to carry!



Other resources and credits:

Stream/river flows data can be found here:

<http://waterdata.usgs.gov/nwis/rt>

Image of rafters:

<http://www.gcdamp.gov/gallery/raft/pages/pg8.html>

Drawn image of foot:

<http://www.ihs.gov/medicalprograms/diabetes/index.cfm?module=toolsFCQuickGuides>